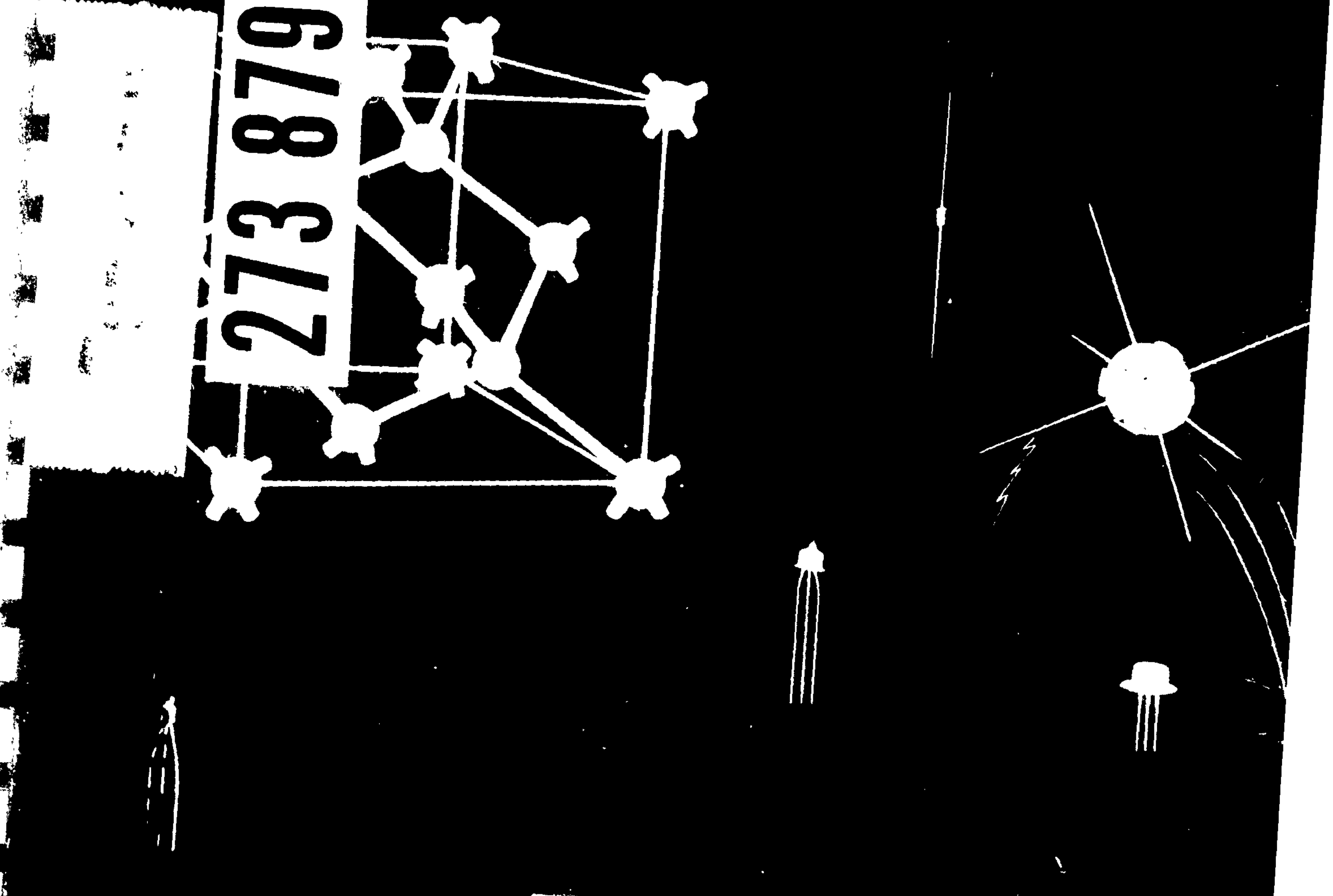

PRODUCTION ENGINEERING MEASURE

DIFFUSED SEMICONDUCTOR DEVICES 7 12 plus 2N559 a... 2N109...

...RTE...Y PROGRESS REPORT
F...R THE PERIOD
...61 TO ...E...EMBER ...961

Con... ...NO. DA-36-039-SC-72729
Ord... ...3888-PP-...-61-61

...D BY
U.S. ARMY SI...NAL SUPPLY AGENCY
PHILADELPHIA PENNSYL...ANIA

Western Electri... Company
...
LAURELDALE PENNS...LVANIA

Copy No. 34

PRODUCTION ENGINEERING MEASURE

DIFFUSED SEMICONDUCTOR DEVICES 7,12 plus 2N559 and 2N1094

QUARTERLY PROGRESS REPORT NO. 17

FOR THE PERIOD

SEPTEMBER 10, 1961 TO DECEMBER 10, 1961

OBJECT: Establishment of Production Design and The Pilot Line Production of Devices 7 and 12 plus the Mechanization of the 2N559 and 2N1094 Transistors

Contract No. DA-36-039-SC-72729
Order No. 53888-PP-56-81-81

Prepared by: M. N. REPPERT
Approved by: R. E. MOORE

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

SECTION I

ABSTRACT

The work accomplished during the seventeenth quarter which ended December 10, 1961 on Phase 2 of the contract is herein reported. All work on Device 7, Device 12 and Device 12 Mechanized has been completed. Closing reports are now being prepared. Contract negotiations initiated during the thirteenth quarter have been completed.

CONTRACT MODIFICATION

Contract Modification No. 19 has been completed. Delivery dates for machines and reports have been extended six months. After a review of all contract worl statements, etc., seven (7) machines were deleted and six (6) other machines were added. This decreased the total machines contracted by one. Thirty-seven (37) machines for twenty-three (23) operations are now contracted compared to the previous thirty-eight (38) machines for twenty-four (24) operations.

DEVICE 7 AND DEVICE 12

Submission of the Final Report and the Bill of Parts and Material during the next quarter will fulfill contracted commitments on this portion of the contract. Delivery date for these reports has been extended to March 31, 1962.

MECHANIZATION 2N559-2N1094

Eleven (11) machines for ten (10) operations have been completed. No machines were completed this quarter, however, progress has been made on twelve (12) of fourteen (14) machines being developed. Seven (7) machines have advanced one phase or more during the quarter. Of the fourteen (14) machines now being developed thirteen (13) are prototypes, and one (1) is a simplified

modification of a prototype. No work has been done on the twelve (12) duplicate machines.

Status of machines presently being developed is summarized in the following paragraphs. Even though overall progress may have advanced beyond a given phase, the status of the machine in this summary is determined by the status of its most incomplete component.

Narratives on the eleven completed machines are included for this report only to note contract modifications affecting them and to review the status of all machines after contract modification. All completed machines are either currently undergoing production trial or are available for production trial except one: The status of the completed Slice Scribing Machine has changed temporarily. Production trial was discontinued recently until its index mechanism is modified to provide four different indexes instead of one. The machine should return to production trial next quarter.

The Wafer Breaking, Loading and Screening Machine has begun shop trial. It should be completed next quarter. An overall machine efficiency of 85 per cent should be increased to 90 per cent with additional operator experience.

In recent months Header Glassing has been reactivated after developing a new process for preparing metal piece parts. A dual zone furnace which will replace four separate furnaces has been purchased and installed, but prove-in has been temporarily delayed by a faulty power supply. Prove-in should be completed next quarter.

The prototype Wire Bonding Machine has continued prove-in through the quarter. Mechanically and electrically it performs satisfactorily. Problems inherent in the bonding technique have slowed prove-in. Some means of repeatedly

severing and controlling the .0005 inch wire after making stripe bonds must be found before further noteworthy progress can be made. In the meantime, a second modified Wire Bonding Machine has entered the construction phase. Construction of this machine should be completed next quarter.

In addition to the second Wire Bonding Machine, three (3) machines are being constructed and portions of a fourth machine are being modified. A new lead feed station and other parts necessary to accommodate header and glassing mold design changes on the Header Assembling Machine have been designed and built. Prove-in will resume next quarter after the redesigned parts are installed. The new Card Trimming and Packaging Machine previously part of the testing machines has completed development and design. Recently Card Trimming has become unnecessary. As a result it is being constructed as a packaging machine only. Prove-in should begin next quarter.

Construction of the Piece Part Cleaning Machine has continued through the quarter and is almost completed. Prove-in of one module has already begun. Prove-in efforts have revealed a need for various basket designs. Handling of modified baskets has created a feeding problem which is being studied.

Three of four machines in design have advanced. No progress has been made on the Coating Machine since suspending work at the completion of design. If a similar Painting and Coating machine now being built performs 2N559 and 2N1094 Coating satisfactorily, this machine will be deleted.

Both design and construction of the newly added Platform Lead Welding Machine have reached the fifty per cent point. Since completing development, time studies of manual operations have been completed. Consequently, a machine output of 1,250 subassemblies per hour has been set. Prove-in should be completed next quarter.

Development of the Closure Welding Machine and a modified replacement Card Loading Machine was completed this quarter. Major components of the Closure Welding Machine have been chosen. Formal design should be completed next quarter. Prove-in of the original Card Loading Machine has been discontinued due to the change in lead length of the 2N559 transistor. Design of a very compact replacement has begun; construction should begin next quarter. The modified machine will occupy about ninety per cent less floor space than its original and can be combined directly with the feeding mechanism of the Testing and Date Stamping Machines.

Three (3) machines have not completed development. Can Getter Assembling Machine progress will depend on development of a getter loading station. Development of this station is held pending specification of the moisture getting material and of the method for adding the getter to nickel powder contained in cans. Other stations are being designed. Construction of some of the stations will begin next quarter.

Major components of the Data Handling System are in various phases. Except for the TACT test set received during the quarter, major components are proved-in. A faulty "h" parameter test module has delayed TACT prove-in. The transistor handling and indexing mechanism is being built. The Data Handling System remains in development because of a switching time test module which is being developed for the test set. This development should not delay system prove-in, however.

Development of the Testing and Date Stamping Machine (2N1094-2N1195) continued this quarter. Operations to be performed by the machine were reevaluated. As a result, a general outline for a modified machine for Testing and Data Collection has been developed. Machine design for the modified operation should begin next quarter.

SECTION II

PURPOSE

The purpose of Phase 2 of the contract is summarized in this section. Portions of the purpose pertaining to Devices 7 and 12 remain unchanged. However, Contract Modification No. 19 has changed the purpose of 2N559-2N1094 mechanization. The following purposes pertaining to Devices 7 and 12 have been met:

1. Provide the production engineering to establish manufacturing techniques and determine appropriate operation for production of the approved devices.
2. Design, develop and procure or manufacture tooling, machinery and test equipment which is required to execute point one, above.
3. Produce pre-production samples which comply with the applicable specifications and submit to the U. S. Army Signal Equipment Support Agency for approval.
4. Produce approved devices on a pilot line.
5. Provide production engineering to establish manufacturing techniques and operations for mechanized production of Device 12.
6. Design, develop and procure or manufacture the necessary machinery, tooling and test equipment required to execute point five, above.
7. Produce preproduction samples which comply with the applicable specifications made by the mechanized production equipment and submit to U. S. Army Signal Equipment Support Agency for approval.
8. Produce approved devices on a mechanized pilot line.

In addition to the above purposes, the following purposes pertaining to Devices 7 and 12 have not been accomplished:

1. Prepare and submit a mobilization planning report on Devices 7

and 12.

2. Prepare and submit a final report covering Devices 7 and 12.

A balanced mechanized production line for 2N559 and 2N1094 transistors shall be provided capable of producing at least 60,000 transistors conforming to applicable specifications per two (2) shift, eight (8) hour, five (5) day week.

Special Note 9 of the contract has been revised in Contract Modification No. 19. The revision changes the ultimate objective of the contract to the following: "... The contractor, in designing and developing these production techniques, shall consider the objectives of establishing the production capacities shown in Nike Zeus Interim Program for limited production dated 21 November 1961."

The following general purposes for 2N559 and 2N1094 mechanization remain unchanged:

1. Provide production engineering to establish manufacturing techniques and operations for mechanized production of the 2N559 and 2N1094 transistors.
2. Design, develop and provide the necessary machinery, tooling and test equipment required to execute point one above.
3. Produce devices conforming to applicable specifications on the mechanized equipment provided, and submit test data as specified.
4. Prepare and submit a mobilization report on the mechanized equipment for the 2N559 and 2N1094 transistors.
5. Prepare and submit a final report covering the 2N559 and 2N1094 mechanization.

SECTION III

DEVICE 7 AND DEVICE 12

Development and pilot production objective for these devices have been met. Subsequent mechanization of four Device 12 operations has been accomplished and the Mechanized Device 12 pilot production has been accepted.

By Contract Modification No. 19, the due date for the Final Report - Devices 7 and 12, and for the Bill of Parts and Material - Devices 7 and 12 have been extended to March 31, 1962. Both the Final Report and the Bill of Parts and Material are being prepared, and should be submitted in February.

SECTION IV

MECHANIZATION 2N559-2N1094

Progress made during the seventeenth quarter in mechanization of individual 2N559-2N1094 operations specified in Contract Modification No. 19 is discussed in this section. These discussions have been expanded for this quarter to review mechanization efforts of completed machines as well as machines now being developed. All machines are reviewed at this time because major contract modifications affecting descriptions and quantities were completed this quarter.

Contract Modification No. 15, July 26, 1960, was the last contract modification affecting the scope of mechanization. Since July, 1960, product design changes, improved techniques, and changes in approach have modified some operations and, consequently, the machines to such an extent that operation or machine descriptions of the contract were redefined in Contract Modifcation No. 19. Descriptions of twelve (12) operations were changed, seven (7) machines were deleted and six (6) machines were added.

Of the seven machines deleted, five were duplicate machines. In addition, two previously separated operations were added to machines performing associated operations thus deleting two additional machines. Both the Date Stamping operation and the Wafer Loading operation were deleted through combination with other operations. A basic approach to Date Stamping was resolved by the fifteenth quarter. At that time a decision was made to combine Date Stamping with Testing and Packaging. In like manner after developing Wafer Loading techniques by the eleventh quarter, a decision was made to combine Wafer Loading with Wafer Screening. Since making these decisions, narratives on these operations have been combined accordingly. In addition to the two deletions

above, five duplicate machines were deleted as follows:

Cleaning and Oxidizing Header Lead Wire

Header Lead Trimming

Card Loading

Gold Wire Handling and Bonding

Testing and Packaging - 2N559

A total of six machines have been added for three separate operations. One operation, Platform Lead Welding is a new one; three machines will be provided for this operation. Two Card Trimming and Packaging Machines were added. Previously, Card Trimming and Packaging was to be performed on Testing and Packaging Machines. An additional Closure Welding Machine will also be provided.

The above additions and deletions decreased the number of machines by one. Thirty-seven machines are now contracted for twenty-three separate operations.

In addition to the foregoing additions and deletions, twelve operation or machine descriptions were changed. These new titles accurately described the machines when Modification No. 19 was proposed and identify the narratives of this section. Both the old and new titles are listed below as a reference since several titles were completely changed even though the operations performed are very similar or identical.

NEW TITLE	OLD TITLE
Cleaning Header Lead Wire	Cleaning and Oxidizing Header Lead Wire
Piece Part Cleaning	Universal Cleaning and Plating
Can Punching and Coding	Can Punching
Can Getter Assembling	Can-Vycor Assembling

NEW TITLE	OLD TITLE
Slice Scribing	Wafering
Wafer Breaking, Screening and Loading	Wafer Screening
Wafer Bonding	Wafer to Header Bonding
Wire Bonding	Gold Wire Handling and Bonding - 2N559 Gold Wire Handling and Bonding - 2N1094
Final Cleaning	Emitter Etching
Closure Welding	Bake-Out and Can to Header Welding
Testing and Date Stamping - 2N559	Testing and Packaging - 2N559
Testing and Date Stamping - 2N1094 and 2N1195	Testing and Packaging - 2N1094

For this report only, due to extensive contract modifications, narratives of completed machines are included to review their status and to note contract modifications affecting these machines. The following eleven (11) machines have been completed:

Cleaning Header Lead Wire

Piece Part Gold Plating

Header Lead Trimming

Strip Perforating and Welding (2)

Header Continuous Rack Plating

Can Punching and Coding

Slice Scribing

Wafer Bonding

Final Cleaning

Testing and Date Stamping - 2N559

No work has been started on twelve reproductions of prototype machines for eight operations. Work has, however, continued on fourteen other machines thirteen of which are prototypes. These fourteen machines have attained the following overall status at the end of the seventeenth quarter:

Shop trial	- 1
Prove-in	- 2
Construction	- 4
Design	- 4
Development	- 3

In several instances major portions of a machine have advanced beyond the phase indicated. However, since the above summary reflects overall machine status, delays in providing certain components may leave the impression of slow progress in certain areas. The general descriptions and details of machine status provided in the remainder of this section will more accurately define their status at the end of this quarter.

CLEANING HEADER LEAD WIRE - R. W. Ingham

GENERAL

The Cleaning Header Lead Wire machine was known as the Cleaning and Oxidizing Header Lead Wire Machine until after its completion during the thirteenth quarter. There have been no modifications of the machine to date that would change its capabilities. After the successful prove-in of other mechanized equipment, the machine will be used only for cleaning one end of the leads preparatory to header assembly. The change in title on Contract Modification No. 19 describes the operation it will perform in the future.

Variations in weight gain, sticking of leads and bent leads during lead preparation in hydrogen atmosphere furnaces prompted an investigation to overcome these difficulties economically. The investigation revealed that the principle benefit of furnace cleaning in a hydrogen atmosphere was removal of drawing compounds, etc. imbedded in the surface, and not previously removed by solvent cleaning. Further, the repeated heating of the entire length of leads had an undesirable annealing or softening affect on the wire leads.

The successful performance of the mechanized operations that followed lead preparation are dependent on availability of straight leads. In order to assure such a supply, furnace cleaning was replaced by the following cleaning process. Straightened precut leads would be placed into a magazine and picked off by a slotted drum. The drum would have to revolve with the same linear speed as the main or transfer table in order to make the lead transfer. After the parts have been located on the main table, they are held in place by the neoprene belt that encircles the main table and feeding device.

The main table which is insulated from the rest of the machine is maintained at a voltage of 6 to 12 volts D.C. above the main machine frame. This poten-

tial difference is necessary for the electropolishing operation which electrochemically removes the contaminated outer layers. Removal of .0006 inch on the diameter is generally sufficient to insure good cleaning. Cleaning acid is continually recirculated by a special acid pump that lifts the acid (90-95% sulphuric acid, 3 to 5% chromic acid, balance water) into the upper tank visible on Figure 4-1. Rate of flow and acid level is controlled by adjusting the percentage of acid that is recirculated. Immediately after removal from the electropolishing tank, the leads are rinsed in warm water to remove any remaining acid. Leads are then subjected to a final spray rinse as an added precaution. The leads are then dried in a special chamber that uses filtered air to remove the bulk of the moisture and heat lamps to complete the drying. The drying operation was inserted mainly to prevent ionization of the water in the Radio Frequency Induction Coil used for oxidizing.

The oxidizing concept used on the Cleaning Header Lead Wire Machine was a radical departure from the established oxidizing procedures. The basis of our oxidizing process is rapid heating of the leads (room temperature to 850°C - 875°C in 1 second or less). Exposure of the lead to the oxidizing temperature for a period of time sufficient to build up the desired oxide weight gain on the leads. The method of weight gain determination was described in detail in Quarterly Report #12.

After all the above operations have been completed, the leads will be counted and unloaded into containers for storage and transfer to the next operations.

ENGINEERING STATUS

The machine has been completed, installed and operable for about nine months. The Cleaning Header Lead Wire Machine has demonstrated that it can produce clean straight wires suitable for transistor headers required by the Nike

Zeus program. The design and build order has been closed and no further work on the original machine is contemplated. Presently, consideration is being given to increasing the diameter of the wire and decreasing the lead length. Both of these changes will require modifications to the lead feeder.

As mentioned earlier in this report, the oxidizing concept was based on rapid heating of the wire leads. Resistance heating was investigated but the difficulties anticipated with resistance heating units of approximately 200 watts per square inch output made them impractical, especially since they were to be operated in air. R-F (Radio Frequency) heating seemed to provide the fastest and most selective heating along with high energy concentration per unit area. Proper spacing of the R-F heating coils was found very important. Due to the small mass of the wire, close coupling was also found necessary; however, if the coils were brought too close to the leads, arcing occurred occasionally. When arcing occurred small balls formed on the lower end of the leads. This condition could not be tolerated since tolerances of the header glassing molds were so close that these leads could not be used. The introduction of inconel reflector plates provided better coupling and allowed wider spacing of the coils. Satisfactory lead oxidizing was then obtained.

Another problem which had to be solved was the selection of a belt that would both clamp and transport leads. In addition the belt had to operate satisfactorily at 150 degrees Farenheit or higher and had to withstand reverse bends. Due to the small number of belts required, many types of commercially available belts were tested in preference to having a special belt designed. Finally a belt manufactured by the U. S. Rubber Company under the trade name of "Power Grip" was chosen. It filled our need most satisfactorily when turned inside out. In addition, it was low in cost and available from stock.

CONCLUSIONS

The machine as designed is capable of producing cleaned straight leads required for subsequent header assembly. It is also capable of oxidizing leads should the need arise.

This narrative has been included during the quarter as a review due to extensive contract modifications. Since the machine is completed, future quarterly reports will again delete this narrative.

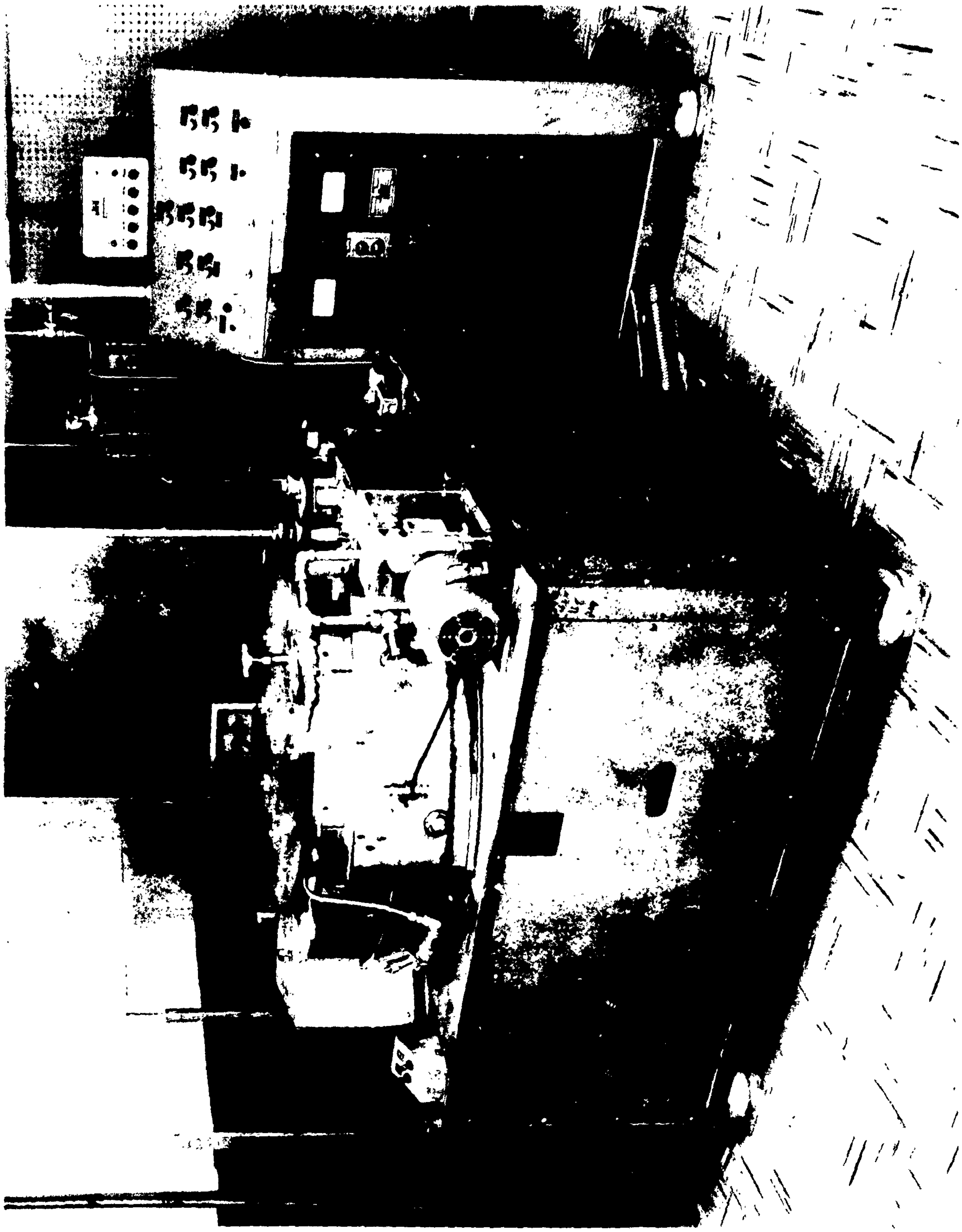

FIGURE 4-1 CLEANING HEAD LEAD WIRE MACHINE

PIECE PART CLEANING - R. P. Loeper, F. J. Reinhard

GENERAL

The Piece Part Cleaning Machine is intended to provide mechanical handling means for moving batches of parts in dipping baskets through a series of tanks. In the tanks, the parts are successively degreased, pickled, etched, rinsed and dried prior to application of a plated finish or prior to immediate use in semiconductor subassemblies. The machine is composed of two assemblies of four modules each, one assembly for ferrous parts and the other for non-ferrous parts.

During the quarter, one module was installed and used for initial prove-in in the plating area while construction continued on the remaining seven modules.

ENGINEERING STATUS

A few problems were encountered in the prove-in of the first module. Temperature control in the tanks was quite erratic; further investigation showed the regulators were not designed for high pressure steam. Steam pressure to the machine was then reduced to 30 PSI with a pressure reducing system. This system has resulted in very good temperature control.

The machine was originally designed to use six inch diameter baskets as a means of conveyance. However, during initial prove-in of the first module, it was determined that many parts could be handled more reliably by other basket designs. Most of these basket designs are very light and, as a result, give trouble in both the entrance and exit stations. Some of the problems arising with other basket designs have been solved, however, the problem of feeding from a supply at the entrance of the machine will need additional attention.

Construction of four modules, which will comprise the first complete assembly, has been completed and the completed assembly was placed in position for final installation. The remaining three modules for the second assembly are past the painting stage and in the final phase of construction.

During construction of the first assembly, modifications were made to the agitator drive to keep it free and clear of existing mechanisms. Brackets for the side gears also were moved to provide the necessary clearance. Minor troubles were encountered with the brass switch enclosures and some rework was needed to clear this trouble.

CONCLUSIONS

The mechanism for handling baskets must be changed to provide a mechanism suitable for various types of handling baskets.

Two machines of four modules each will be provided for Piece Part Cleaning, one will be used for ferrous parts while the other will be used for non-ferrous parts. Initial work with the drier points to a need for some additional study on this station.

OBJECTIVES FOR THE NEXT QUARTER

1. Complete installation and prove-in of the eight modules.
2. Continue corrosion rate studies.
3. Develop a mechanism to handle baskets of various sizes and geometry.

PIECE PART GOLD PLATING MACHINE - C. P. Comins

GENERAL

The Piece Part Gold Plating Machine is a general eight-station conveyorized automatic barrel plating machine capable of gold plating headers and cans. Based on an analysis of the proposed schedules and prints of the parts to be plated, it was decided to purchase initially a barrel plating unit with considerable flexibility of plating cycles and adaptable for plating different parts.

This machine was completed during the eleventh quarter after overcoming a header plating problem.

ENGINEERING STATUS

The machine purchased was basically the Abbey Process Automatic Single Barrel Plating System with several of our modifications added. Stations were provided for the following operations:

1. Alkaline Degrease and Rinse.
2. Hydrochloric Acid Pickle and Rinse.
3. Cyanide Dip and Rinse.
4. Copper Plate and Deionized Water Rinse.
5. Gold Strike and Gold Plate.
6. Gold Reclaim Rinse.
7. Room Temperature and Hot Deionized Water Rinses.
8. Loading and Unloading Stations.

The machine is of a modular unit construction. Each self-contained module or station has identical frames, elevators, hydraulic lift cylinders, solenoid valves and limit switches and are coupled to one another forming a closed continuous loop. Although each module is mechanically similar, their

function can be altered by varying the interconnecting electrical controls.

The mechanical operation of a typical stations is as follows: The chain drive conveys the free wheeling carrier to which the plating barrel is attached along the overhead monorail trackway to the first position. At this point, the carrier activates a limit switch causing the reciprocating overhead transfer bar to push the barrel to a predetermined position on the station elevator where another limit switch is tripped. This limit switch activates a relay which starts the elevator downward to the plating bath. In its downward descent bus bar contacts are made with a rectifier which provides D.C. current for cleaning or plating. A.C. current is provided through other bus bar contacts for operating the motor drive which rotates the plating barrel. The length of time the barrel is in the plating bath is controlled by the master panel. At the completion of the set time, the elevator rises to the overhead monorail and the barrel is pushed by the overhead reciprocating bars to the next station programmed by the master panel. The master panel controlling the machine is composed primarily of timers and relays which control the individual stations. When a cleaning and plating cycle is programmed into the panel, the entire cycle, once started, is completed automatically.

In addition the following features were installed:

(1) Continuous filtration systems for the gold and copper cyanide baths.

(2) Conductivity control for the rinse tanks between hydrochloric acid and cyanide baths. (The barrel will not transfer from the acid rinse tank to the cyanide tank unless the parts are adequately rinsed thus preventing accidental carryover of acid into

the cyanide bath.)

(3) Ampere hour meter to control the amount of gold deposited on the piece parts.

(4) Manual controls at each station that can override the automatic controls.

(5) Individual temperature control of the various baths.

(6) A ventilation system.

Considerable effort was expended in evolving the design of two different types of internal cathode rod contactors used in the plating barrels. One system of internal cathode rod contactors located in the apexes of the plating barrel eliminated the problem of bending of the tubulated cans and also provided a burnishing action on the gold plate which improved corrosion resistance. The other system, integrated with a compartmentalized barrel, markedly decreased the tangling and bending of the header leads during plating.

If it becomes necessary to enlarge the machine for increased production, additional stations can be added in the return loop. The machine can also be easily converted from a single to multibarrel unit. Another feature which can be added is a punch card system which will permit several barrels to go through the machine simultaneously each with a different cleaning and plating cycle.

CONCLUSIONS

With the existing controls, the cleaning and plating cycle can be changed, if desired, after each run. Cans have been successfully barrel plated in this machine with a greater than 99% yield. Headers have been plated at a greater than 90% yield.

Since this machine was completed previously, this report will again be deleted in future quarterly reports.

PLATFORM LEAD WELDING - R. P. Loeper

GENERAL

Header design changes completed during the past quarter have required the addition of this operation prior to Header Assembling. This subassembly operation will be performed by three new Platform Lead Welding Machines, added by Contract Modification No. 19.

The Platform Lead Welding Machine is designed to assemble the collector lead and platform and, after assembly, butt weld the two parts. The machine consists of an indexing table with four sets of tooling which permit simultaneous performance of the four steps involved in the operation. At the first station a platform is hand loaded, at the second station a lead is hand loaded, at the third station the assembled parts are automatically welded, and at the fourth station the welded assembly is unloaded by hand.

During the 17th Quarter development was complet ', and design and construction were begun.

ENGINEERING STATUS

Originially, a completely automatic machine was considered. Closer analysis of the mechanisms needed to handle the leads, platforms, and welded subassemblies altered initial thinking. The analysis indicated that a semi-automatic machine was more feasible than a fully automatic machine in view of anticipated time schedules.

Initially, two problems were anticipated: gripping the lead close to the end to be welded, and repeated alignment of the lead to close tolerances. A small boss turned on the upper electrode permitted the electrode to enter the cup portion of the platform. Thus, only a short length of lead wire projected

from the electrode and a very satisfactory weld could be made. Accurate alignment of the parts before welding was obtained by designing a die set type aligning fixture.

The base of the aligning fixture has aligning pins which accurately guide the moving upper part of the fixture. The lower electrode is mounted in the center of a ceramic block, which provides electrode insulation and also serves as a pocket for locating the platform in the aligning fixture. The ceramic block is mounted on a pair of thin steel cantilever springs which are deflected to provide the welding force and follow-up needed after making the weld. This ceramic block assembly is mounted on a cam operated cross slide guided on the main base. This cross slide in the forward position, places a locating screw under the upper electrode for positioning the lead wire with the proper length exposed; in this same forward position, the cross slide also moves the ceramic block forward providing access for removing the welded sub-assembly and for loading another platform. In the retracted position, the cross slide is free of the cam, and an adjustable stop limits retraction. When the cross slide is retracted against the stop the header platform is aligned with the collector lead wire at the welding station. The top electrode is mounted on another slide which provides vertical travel. A partially slotted copper electrode is mounted on this vertical slide. The slotted part of the electrode is sprung open automatically and a small cam lock forces it together. This cam permits the slot to assume three positions: fully open, lead load or semi-closed, and clamped.

The cross slide of the lower electrode, the cam lock for upper electrodes, and the upper electrode height control operate automatically as they revolve around cams mounted on a stationary center post. Welding current to

the four stations is timed by means of the index table.

Construction following the above design was initiated during the quarter. Earlier in the quarter, a time study of manual operations was made during the machine development. The following results were obtained:

1. Taking a lead from a group held in the left hand and placing it into the upper electrode: 2,550 leads, estimated hourly output.
2. Taking a platform from a petri dish and placing it into the ceramic block: 1,470 platforms, estimated hourly output.
3. Revmoving the welded assembly from the ceramic block and placing it into a glassing mold: 1,720 assemblies, estimated hourly output.

CONCLUSIONS

1. A semi-automatic design was chosen after analysis of rates and production level.
2. From the time study of manual operations involved in operating the machine, a goal of 1,250 welded assemblies per hour has been set.
3. Development of this machine is completed; design is 80 per cent completed; and construction is 50 per cent completed.

OBJECTIVES FOR THE NEXT QUARTER

1. Complete design, construction and prove-in.
2. Write and issue the Operation and Maintenance Specification.

HEADER ASSEMBLING - R. P. Loeper

GENERAL

A header design change has modified the Header Assembling operation. The revised operation will mechanically add two leads and glass piece parts to every collector lead-platform assembly, contained in a mold, prior to sealing in a furnace. An additional design change was made to the glassing molds. These design changes have made two stations of the Header Assembling Machine obsolete, and have necessitated the redesign of several other stations.

ENGINEERING STATUS

The header design change which incorporates a butt welded collector lead has required a new lead feed station. Design and construction of this station is now complete. The revised glassing process requiring a cermaic glassing mold also made changes in the track feed, mold locators and indexing mechanism mandatory. These parts are now made but have not been installed. Parts necessary for the rotating of the tip weld station 90 degrees have also been made, but installation has not begun.

CONCLUSIONS

Parts and stations necessary to incorporate header and glassing mold design changes have been constructed. Installation has not begun.

OBJECTIVES FOR NEXT QUARTER

1. Install modified parts and stations.
2. Prove-in the reconstructed machine.

HEADER GLASSING - L. R. Sell

GENERAL

Header Glassing has not been reported since the thirteenth quarter. At that time a determination was made not to construct the machine due to header design changes and current developments in glassing techniques. Two innovations in header processing since the thirteenth have reactivated Header Glassing during this quarter.

The Header Glassing Furnace is being developed to streamline the various operations that glass and rodar components are subjected to in the process of assembling and glassing.

Four different furnaces are presently utilized for header processing: two furnances for lead preparation, one dual-purpose furnace for platform preparation and one furnace for header glassing. Header processing now requires three processes as listed below:

1. Leads Preparation
    a. Chemically cleaned
    b. Pre-oxidized in conveyor furnace
    c. Chemically recleaned
    d. Decarburized in pusher furnace
    e. Oxidized in conveyor furnace
2. Platform Preparation
    a. Chemically cleaned
    b. Decarburized and oxidized in Tandem conveyor furnace
3. Assembly and Glassing
    a. Assemble glass and metal
    b. Fuse glass at 1000°C in glassing furnace with slightly

oxidizing atmosphere.

Recent developments in raw material preparation has enabled suppliers to furnish carbon-free rodar material, therefore decarburization has been eliminated from the new Header Glassing process. This development, however, is independent of the dual-purpose furnance innovation.

The new Header Glassing Furnace is a dual-purpose furnace which will perform all furnace operations on one pass through the furnace. The following steps outline header processing using the new Header Glassing Furnace:

1. Chemically clean leads
2. Chemically clean platforms
3. Load piece parts in glassing molds
4. Oxidize metal piece parts at 800°C and then heat to 1000°C for glassing in dual-purpose furnace.

The Header Glassing Furnace is 36 feet long, six feet high and two feet wide. It consists of four zones: The first, or preheat zone, raises the temperature of the header to 800 degrees Centigrade in a nitrogen atmosphere. The second zone is the oxidizing zone (800°C) and contains dry air. The third zone is the glassing zone (1000°C) and contains nitrogen. The last, or cooling zone, contains nitrogen and anneals the glass seal while bringing it down to room temperature. A diapharm (patent pending, BTU Engineering Corp.) on either end of the oxidizing zone prevents nitrogen from entering the oxidizing zone or oxygen from leaving the zone.

The glassing molds are carried through the furnace on an inconel conveyor belt. A pneumatic pusher rod automatically loads the boats on the conveyor from a conveyorized side feeder. Up to fifteen boats can be loaded on the side feeder at one time.

Seven separate heating controls are provided for the four zones. One for pre-heating, two for oxidizing, three for glassing and one for cooling. The multiple controls in the oxidizing and glassing zone provide control of plateau length as well as the peak temperature. A twelve point strip chart recorder gives a running profile of the furnace temperature. Four Weston Sensitrol instruments provide overtemperature safety. As soon as a furnace temperature exceeds the pre-set Sensitrol temperature all power to the furnace is shut off.

ENGINEERING STATUS

The furnace was constructed during the past quarter by the BTU Engineering Corporation, Waltham, Massachusetts. It has been delivered and installed. Prove-in has begun.

During initial prove-in all zones, except Zone 1 have attained operating temperature. Difficulty is being experienced with one of the Stepless power supplies of Zone 1. Engineers from BTU Engineering Corporation will soon rectify this situation.

CONCLUSIONS

No unusual design or construction problems have occurred to date. All equipment on the furnace, except Zone 1 power supply, is working satisfactorily.

OBJECTIVES FOR THE NEXT QUARTER

1. Complete prove-in.
2. Start shop trial.

HEADER LEAD TRIMMING - Q. L. Schmick

GENERAL

The Header Lead Trimming Machine will trim the three internal header leads after Header Glassing. After lead trimming, it will also notch, bend and weld the collector lead to the platform. Eight stations are provided to perform these operations as follows: load, idle, trim, notch, bend, weld, unload and idle. Untrimmed headers are manually loaded in nests on a turret and are indexed from one station to the next by an intermittent motion after each step is performed.

Previously, these operations were performed on bench fixtures which operated at different rates. The machine output was set at 600 per hour, the approximate output of the slowest bench operation.

Since the machine was completed during the fourteenth quarter, it has been available for production trial. Major problems encountered while developing and perfecting the machine are summarized as a review.

ENGINEERING STATUS

After overcoming a burring problem during prove-in, 98 per cent of the output was acceptable. It is felt that with further refining of operations a 99 per cent acceptable output can be realized. The machine is available for production trial; however, its ultimate use may be limited by header design changes and by improved Header Assembling and Header Glassing techniques.

Even during design and build, header design considerations created three delays which extended the machine schedule. During development both header loading and a collector lead bending problem were studied.

Originally, a crimping technique was chosen to assure proper collector lead

wire bending before welding. After further study a notching technique was substituted because it simplified the operation and minimumized maintenance. The header loading problem was overcome by eliminating orientation devices in the redesigned header loading tool.

As stated previously, prove-in involved eliminating the one major problem: the burr that formed during the trimming operation. To minimize the burr, a new cutter feed cam was designed. To overcome the burring problem completely, a lead support plate was added to the trimming tool. This support plate opposes the lead cutter and supports the lead until it is completely severed.

CONCLUSIONS

The Header Lead Trimming Machine is completed and performs satisfactorily. It has produced 98 per cent acceptable trimmed and welded headers.

Since the machine was completed previously, this narrative will again be deleted in future quarterly reports.

STRIP PERFORATING AND WELDING - R. P. Loeper

GENERAL

The Strip Perforating and Welding Machine prepares unplated headers for gold plating by mounting them on a perforated strip. This strip is used as a transport medium for processing headers through the Header Continuous Rack Plating Machine. The Strip Perforating and Welding Machine punches exactly positioned holes which are used as guides in a continuously fed steel strip; it then welds properly positioned headers to this strip. (See Figure 4-2.) The perforator and welding electrode are driven by a motor which provides a smooth but eccentric motion. Headers are located and fed to the welding station by locating blocks attached to a chain drive. The chain is indexed by a ratchet mechanism operated from the welding electrode drive. This same welding electrode drive actuates a hitch feed mechanism which pulls the strip through the machine. A small escapement working in the punched holes and timed by the punch, moves the tape a fixed distance after every punching cycle.

ENGINEERING STATUS

The two machines built under this contract are completed and installed for production trial. The second machine is a duplication of the first. Two major problems were encountered during prove-in of these machines. Both the tape drive mechanism and the drive for the take-up reel were modified before they operated satisfactorily.

The original concept of the machine called for a 0.010 inch thick tape as the transport medium for the Header Continuous Rack Plating Machine. As prove-in of the Header Continuous Rack Plating Machine progressed, it was found that a .015 inch thick tape was required to provide additional strength. Increasing

strip thickness introduced a problem on this machine: the friction drive used for feeding the tape through the Strip Perforating and Welding Machine did not have enough friction to pull kinked portions of the .015 inch thick tape through the strip guides. A sprocket driven by a hitch feed mounted on a spring loaded arm replaced the friction drive. The spring loaded arm is released slowly at the proper time by the same eccentric motion that drives the welding electrodes and header index mechanism. The modified tape drive feeds the thicker strip satisfactorily.

Another troublesome problem was encountered with the take-up reel drive. This drive must vary in angular velocity as the tape builds up from a 12 inch diameter at the base of the reel to a 24 inch diameter when the reel is full. In addition, as the reel fills the force which the reel is exerting on the strip at point of take-up is changing. Originally a leather faced, spring loaded clutch was considered adequate. During prove-in this clutch was a source of trouble. An electro-magnetic clutch whose magnetic field could be varied by a potentiometer, was substituted for the original clutch. The potentiometer was conveniently mounted atop the control panel. This electro-magnetic clutch has been operating satisfactorily.

The two Strip Perforating and Welding Machines were originally designed for welding TO-18 header to the strip. Additional tooling has been provided to weld the TO-5 header to the strip. This tooling is in the form of a chain of locating blocks, similar to the TO-18 chain; however, the pockets of these locating blocks are adapted for the 200 mil pin circle TO-5 configuration. Consequently, locating block spacing was increased to 1/2 inch since the machine was originally built for the 1/4 inch spacing for welding the TO-18, 100 mil pin circle header. To provide 1/2 inch spacing an

alternator, in the form of a microswitch is provided so the welder will only be energized on every other stroke when a header is at the welding station. Even though the welder is only energized on every other index, the 1/4 inch index is required since perforations are still needed at 1/4 inch intervals.

CONCLUSIONS

Facilities for strip perforating and for welding either TO-5 or TO-18 headers have been installed for production trial. These facilities will prepare 38 feet of strip per hour with either TO-18 headers spaced at 1/4 inch intervals or TO-5 header spaced at 1/2 inch intervals.

This narrative has been included as a review for this report only since the machine has been completed previously.

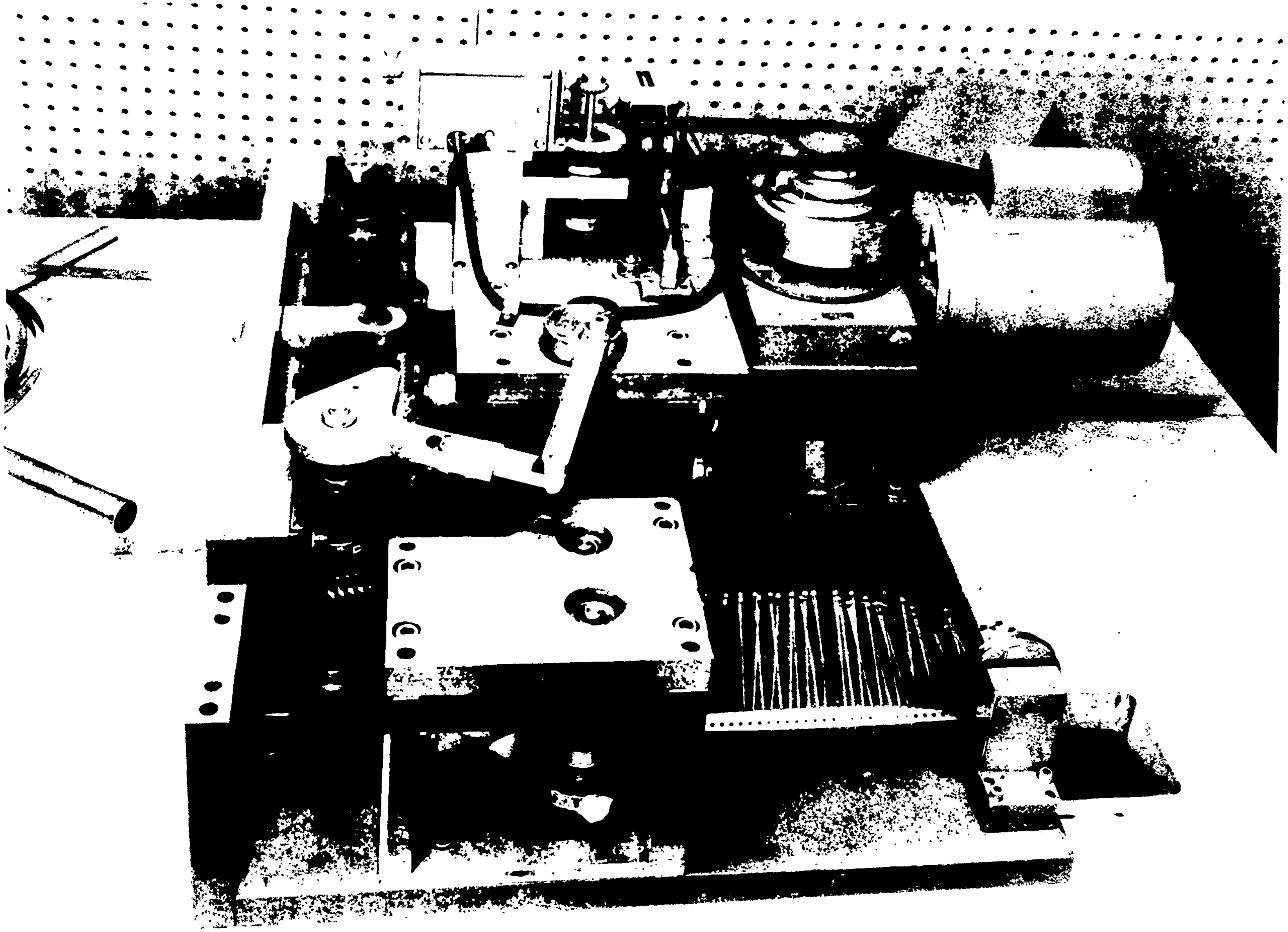

FIGURE 4-2 STRIP PERFORATING AND WELDING MECHANISM

HEADER CONTINUOUS RACK PLATING - R. P. Loeper

GENERAL

The Header Continuous Rack Plating Machine takes the continuous steel strip, which was processed by the Strip Perforating and Welding Machine and passes it through various cleaning and plating baths, water spray rinses, and a hot air drier. At fixed points in the travel through the machine, the strip is depressed into the tanks by running underneath partially submerged rollers; at other points the strip is rotated into a vertical position with the headers down. When the strip is in the vertical plane, tank ends are cleared by passing the strip between guide rollers which temporarily twist the strip toward the horizontal. Untwisting the strip again lowers the headers into the next tank. Figure 4-3 is a photograph of the machine viewed from the reel stands.

The main problem encountered in the development of this machine was feeding the strip through the machine.

ENGINEERING STATUS

The Header Continuous Rack Plating Machine built for cleaning and gold plating headers was completed during the fifteenth quarter. The machine has been installed in the plating area in preparation for the pilot production run.

The strip feeding problem was greater than anticipated. The stresses increased to such an extent that the .010 inch thick perforated strip parted on several occasions. Strip thickness was increased to .015 inch as the first step in overcoming this problem. In addition, three other changes were also made to reduce the stress on the strip as it passed through the machine. The first change consisted of substituting immersed rollers for the twisting roller at certain stations. These immersed rollers were used in every tank

up to and including the gold flash tank. This change reduced drag approximately 20 per cent. Immersing the strip, cleaning, and flash coating during immersion protect the strip from corrosion during storage. Gold flashing the strip added another step to the process since the gold on the strip had to be reclaimed. Later in the development of the machine, the position of the strip during gold flashing was again changed to the twisting motion. This change left a copper plated protection on the strip but no gold flash, thereby eliminating the problem of reclaiming gold from the strip after removal of the plated headers. The second change involved reducing the unreeling friction of the loading station. This drag had a great affect on load applied to the strip as it passed through the various rollers. The third and, perhaps, the most effective change was the placing of two auxiliary drives at the corners of the machine to help pull the strip through the rollers.

Tracking of the strip through the machine is obtained in several ways: At some points the rollers are shaped so the strip runs against a flange, at other places sprockets are used and, lastly, rollers are skewed at other points to provide proper tracking. The main drive at the output end of the machine consists of a pair of rubber covered magnetic rolls driven by a chain. By changing sprocket diameters, some changes in feed rate can be accommodated. The auxiliary drives can also be changed readily.

Other design modifications made during prove-in involved the spray arrangements, the steam wipe action and the height adjustment at second gold plating. By the addition of nozzles and more effective placing of the nozzles, a very effective spray pattern was produced. The steam wipe action preceding the hot air drier also gave trouble. The plant steam provided was dirty

and also did not give adequate wiping action. Finally, steam wiping was eliminated after improving the deionized water rinse. By providing an adjustable stand pipe, the level of the strip can now be changed over the second gold plate tank so headers with other lead lengths can be accommodated.

CONCLUSIONS

Facilities for gold plating headers are installed in the plating area. These facilities will gold plate 2,000 TO-18 Headers per hour with 50 MSI of gold on the leads and 150 MSI of gold on the header while keeping the leads straight and submitting each header to identical conditions. This machine will also clean and plate 1,000 TO-5 headers per hour.

This narrative has been included as a review for this report only since the machine has been completed previously.

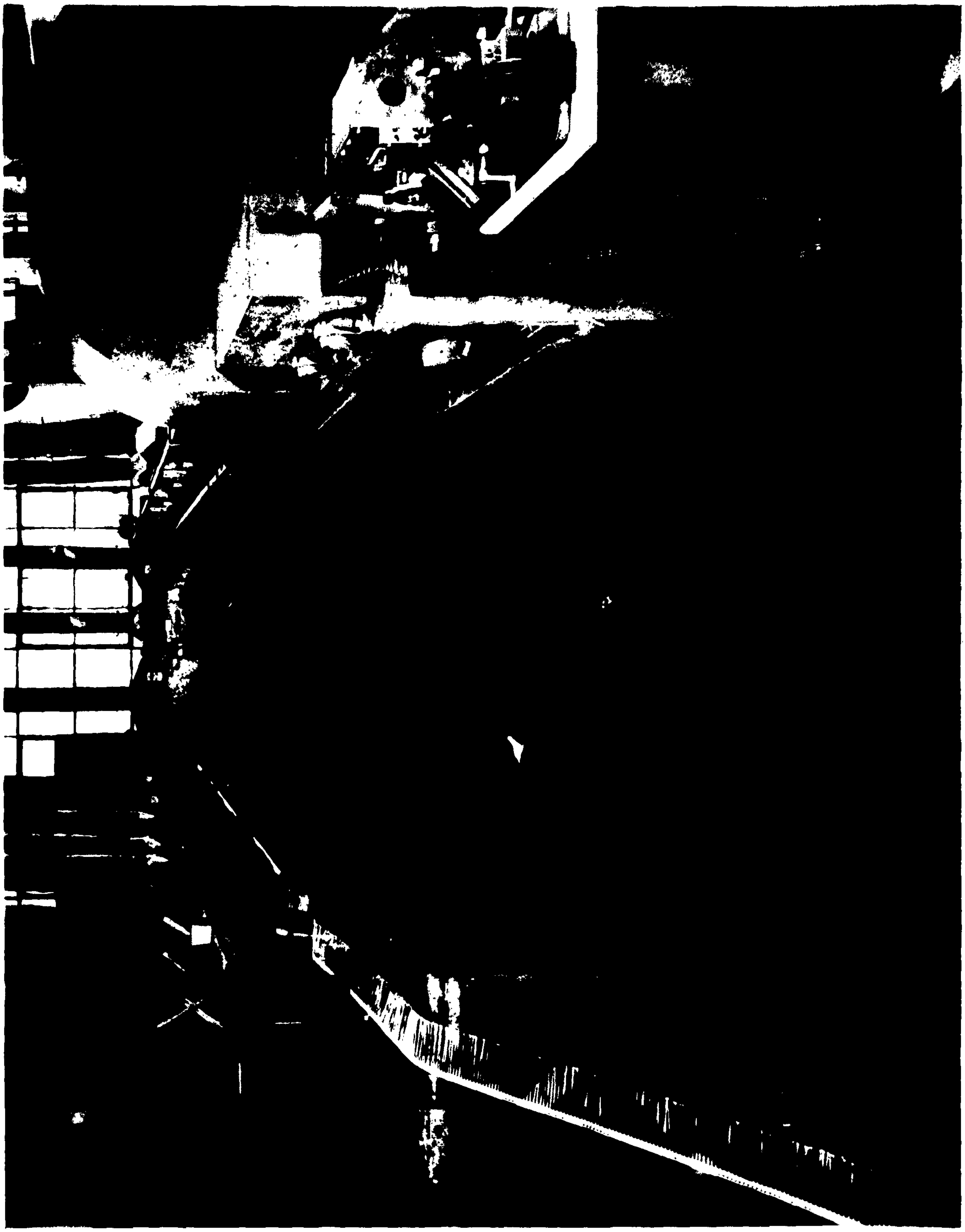

FIGURE 4-3 HEADER CONTINUOUS RACK PLATING MACHINE

CAN PUNCHING AND CODING - J. J. Lorenz

GENERAL

The Can Punching and Coding Machine, a commercially produced Baird #3-25 multistation transfer press, blanks a basic disc from a continuously fed metal strip; then draws, forms, trims, and embosses coded figures on the side of the can in a series of six successive operations. The parts are carried individually from station to station by means of a transfer slide equipped with spring loaded transfer fingers. A finished part is ejected with each stroke of the press once the initial line has been established. The press is currently set to produce 4,000 cans per operating hour.

ENGINEERING STATUS

The machine is complete and capable of producing coded cans in quantity. The problems encountered during its development were general in nature and common to the development of this type of fabrication. The code stamping phase requires a greater than average degree of control over tool dimensions and transfer accuracy.

CONCLUSION

The Can Punching and Coding Machine has been completed; therefore discussion of this machine will not appear on future reports.

CAN-GETTER ASSEMBLING - R. W. Ingham

GENERAL

Formerly, Can Getter Assembling was entitled Can-Vycor Assembling. The title has been changed so it conforms with the new contract designation for the operations.

Originally, the Can Getter Assembling operation consisted of inserting a preformed vycor disc into a can and retaining it with a specially designed clip welded to the can. Difficulties connected with the automatic assembly of this design led us to seek other assembly methods.

A piece of wire having one end mushroomed by cold forming was developed as a result of our investigation. This nail head, as we referred to it, was resistance welded to the can and served as the vycor disc retainer. A strong assembly resulted. The sketch below shows a sectional view of the proposed assembly.

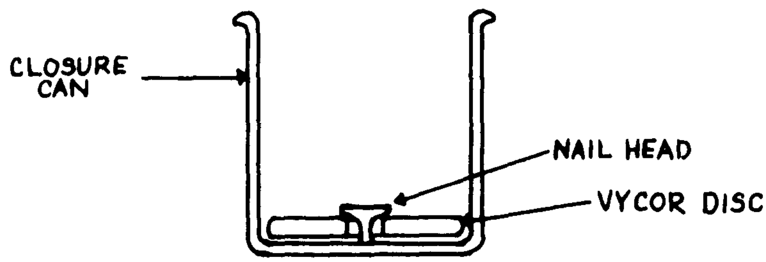

Figure 4-4. Proposed Nail Head Can Getter Assembly.

The above design was abandoned when a more efficient moisture getter was fabricated.

The machine now in the design phase will feed and orient closure cans open side up and place them in a platten. A separate station, for introducing the nickel powder, will measure out (on a volume basis) predetermined amounts of nickel powder and discharge it via gravity into the closure cans. The machine will then index the platten to a station where the powder will be

leveled and compacted by a vibrator and spring loaded plungers. The platten will then be indexed into a magazine holding up to 25 loaded plattens for storage or transport to a sintering furnace.

ENGINEERING STATUS

Presently, the machine is in the design and detail phases. Initial layouts and assembly drawings are about complete for the can loading, the powder loading, the powder leveling and the magazining stations. The feeder for the can loading station has been ordered; delivery is scheduled for February 9, 1962. The portion of the machine for introducing the moisture getting material has not been developed because the method to be used has not been resolved. A decision has been promised by January 15, 1962. Design of the getter loading station will require six to eight weeks after the method of introducing the moisture getting material is resolved.

CONCLUSIONS

Indecision as to the type of moisture getter and its method of introduction have caused delays that will make it difficult to meet schedules previously furnished. Further delays will require rescheduling during the construction phase.

OBJECTIVES FOR THE NEXT QUARTER

1. Complete design and detailing of the machine except for the getter loading station.
2. Start construction of the machine.

SLICE SCRIBING - H. K. Naumann

GENERAL

The Slice Scribing Machine receives evaporated germanium slices and automatically scribes them, in two directions, to a high degree of accuracy. Scribing is accomplished by drawing a diamond tipped scriber across the slice, raising the scriber, indexing the slice, returning the scriber to the start position and repeating the cycle.

The slice is held on the index table by a vacuum chuck. The chuck can be manually rotated to permit scribing in two directions, 90 degrees opposed, and to align the slice when it is mounted on the vacuum chuck. A toolmakers microscope is permanently fixed on the machine to facilitate viewing the slice while scribing and while aligning the slice before scribing. Indexing of the chuck is accomplished by a .020 inch pitch precision lead screw driven through a single revolution clutch. Scribing action is obtained from a separately driven cam shaft.

ENGINEERING STATUS

The Slice Scribing Machine was placed into the shop for production trial July 1960. The machine operated satisfactorily with only minor interruptions until December 1961. In December the machine was returned to the prove-in area for minor modifications.

Since conception of this machine, it has become desirable to scribe on .020, .030, .040, and .050 inch centers at will. This will be accomplished by modifying the single revolution clutch to provide one half revolution indexing and by adding three clutch control cams. Other modifications being made at this time include changing the main drive from a chain to a timing belt drive and modifying the scriber holder to permit scribing with a new

type diamond scriber.

Only minor problems were encountered during the construction and prove-in phase of this machine. They include excessive vibrations from the chain drive and a slipping clutch. In order to reset the index table it was necessary for the spring type single revolution clutch to drive in both a forward and a reverse direction. This was accomplished with only minor success by introducing drag on the spring. A permanent solution to the problem was obtained when a ball and detent were added to the clutch to permit reverse operations similar to a roller type clutch without interfering with the normal forward operation.

Two other minor additions provided better control of the machine. An interrupting switch was added to facilitate stopping the machine at any time during the scribing cycle. To prevent coasting of the scriber cam shaft when the scribing cycle is interrupted, an electric brake was added to the scriber drive motor.

CONCLUSIONS

The completed Slice Scribing Machine has operated satisfactorily in production trial since July 1960. In December 1961 production trial was interrupted for minor modifications.

OBJECTIVES FOR NEXT QUARTER

1. Complete modifications.
2. Complete prove-in and shop trial.
3. Resume production trial.

WAFER BREAKING, SCREENING AND LOADING - Harry K. Naumann

GENERAL

In accordance with Contract Modification No. 19, the title of this operation was expanded to describe all operations performed. Consequently, the title has been changed from Wafer Screening to Wafer Breaking, Screening and Loading.

The Wafer Breaking, Screening and Loading Machine receives scribed germanium slices, breaks the slices into individual wafers, passes the wafers under an optical comparator for visual inspection and then places the wafers into carriers which supply wafers to the Wafer Bonding Machine.

Prove-in has been completed and operation and maintenance specifications have been written.

ENGINEERING STATUS

Prove-in of the machine has been completed and limited quantities of scribed germanium slices have been processed during this quarter.

An estimated hourly output of 1200 inspected wafers was obtained from test runs of 15 to 20 minutes duration. Data collected during these test runs indicate an overall machine efficiency of 85 per cent. This efficiency should increase to 90 per cent with additional operator experience.

Since the wafers are mechanically transferred to the carriers after visual inspection, it is vital that the wafers are not damaged during this operation. Inspection of loaded carriers revealed no signs of damage to the wafer resulting from this transfer. Reliable operation of the machine depends upon the uniform slice scribing, and upon proper breaking along the

scribed lines. Neither of these requirements present a major problem. Scribing requirements can be met and proper breaking is assured when adequate precautions are taken.

CONCLUSION

Test runs have indicated that with accurate scribing and proper slice breaking the machine is capable of performing the required operations with a minimum of operator effort, time and maintenance. The special 300X lens and fresnel type view screen used on the optical comparator produce a large clear image for wafer inspection.

OBJECTIVE FOR THE NEXT QUARTER

1. Complete shop trial runs.

WAFER BONDING - Q. L. Schmick

GENERAL

Contract Modification No. 19 changes the title of this operation from Wafer to Header Bonding to Wafer Bonding. Consequently, the title of this narrative has been changed. Three machines are still contracted for 2N559-2N1094 Wafer Bonding by the modified contract.

The Wafer Bonding Machine (Figure 4-5) is an in-line, intermittant type machine having three major work stations. It receives screened, oriented wafers from the Wafer Breaking, Screening and Loading Machine. After mechanically transferring and positioning, the wafers are gold-germanium eutectic bonded to hand-loaded headers. Wafer bonded assemblies are then mechanically unloaded for further processing.

This machine has been designed to improve reliability level of the Wafer Bonding operation. The present manual process relies heavily on operator skill and techniques and involves a realtively long heating cycle.

ENGINEERING STATUS

The first Wafer Bonding Machine was completed during the sixteenth quarter. Production trial has not begun, since the machine has not been moved to the production area. Neither has work begun on the two remaining machines.

During machine development, three major problems were resolved: accurate header location, accurate wafer location and header heating. Header location was resolved by using a spring balancing technique. Here, one spring worked against another to seek a center due to stress balancing. Accurate wafer location was obtained by designing an accurate transport tray which could be adapted to the machine.

Quick header heating was obtained by using the header as a resistor in a circuit. Temperature control was facilitated by confining the area of the header that is used as a resistor.

Design and construction were not beset by any major problems; however, progress during these phases was slower than expected. As a result, the machine entered prove-in behind the original schedule.

During prove-in, loading, unloading and indexing were the major problems encountered. The loading problem was remedied by adding retaining springs in the load tube and by adding header transfer springs which positioned headers at the correct time. Mechanical helping arms were added to the unload mechanism to overcome the unloading problem. The indexing problem was also overcome by adding mechanical helpers to the corners of the track which controlled the index motion.

CONCLUSIONS

This machine performs the intended operation satisfactorily since overcoming prove-in problems. It is now available for further refining during production trial.

Since this machine was completed during the past quarter and its status is reviewed this quarter only, this narrative will be deleted until activity can be reported on the other machines contracted.

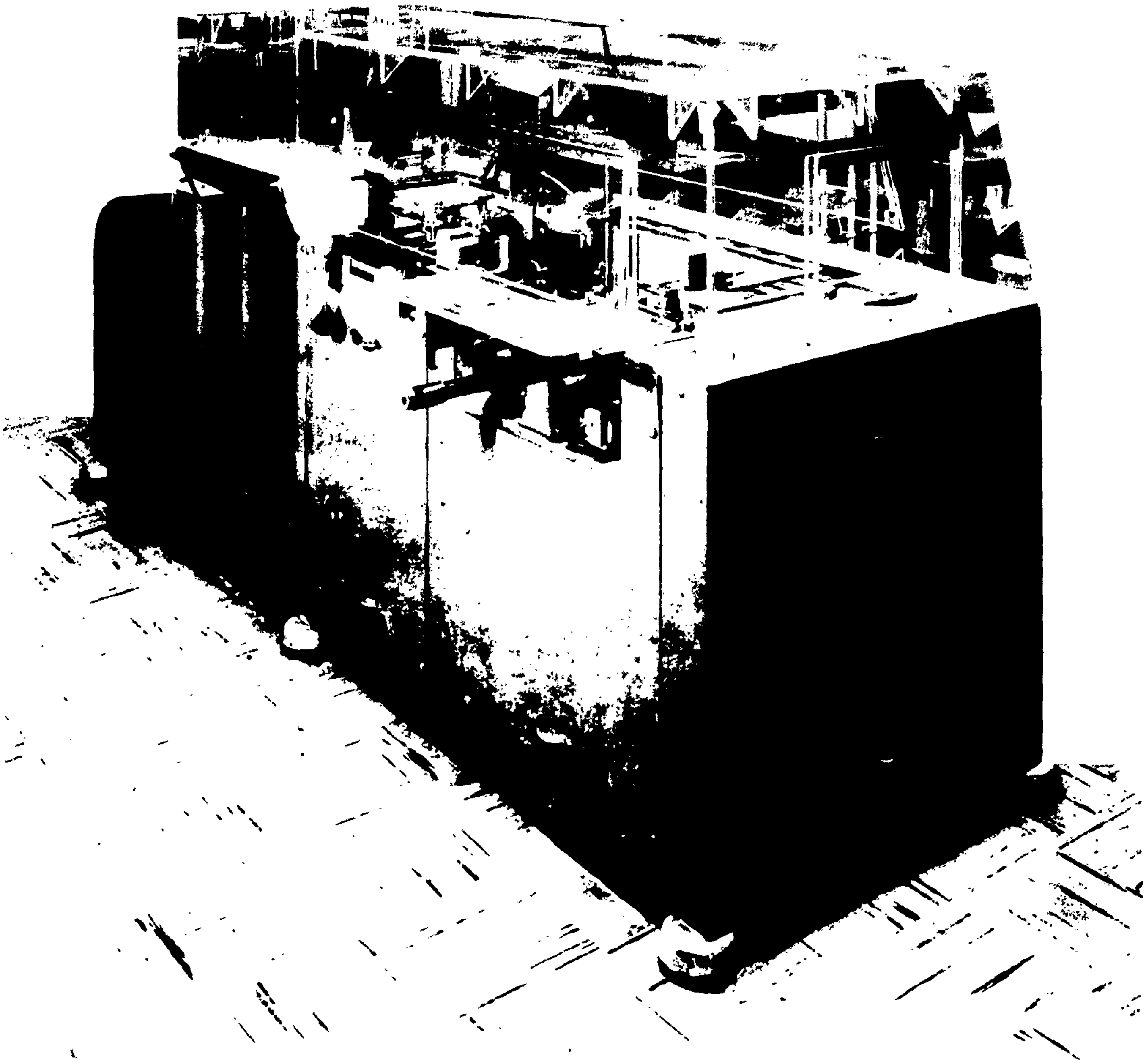

FIGURE 4-5 WAFER BONDING MACHINE

WIRE BONDING - M. K. Avedissian

GENERAL

In previous quarterly reports, this operation was entitled Gold Wire Handling and Bonding - 2N559 and 2N1094. This title has been changed to Wire Bonding to conform with the revised title in Contract Modification No. 19. Six machines, one less than previously specified, are contracted in the latest modification. Both 2N559 and 2N1094 Wire Bonding will be performed on these machines.

The Wire Bonding Machines attach small diameter gold wire to stripes of semiconductor wafers and to appropriate internal header leads. Platform assemblies, previously wafer bonded and loaded in magnetic trays, are automatically transferred through the machines from the supply to the receiving magazines. Bonding stations are provided for the bonding operations. Dwell time of the bonding tools mounted on the bonding station is selected to produce bonds capable of withstanding 20,000 g's acceleration.

Presently, work is in progress on two wire bonding machines: the first machine is in the prove-in phase; the second has entered the construction phase. The first machine employs longer bonding dwell times; therefore, two identical bonding stations are incorporated for higher rate of production. Through two separate optical comparators one operator orients platform assemblies at both bonding stations.

The second wire bonding machine employs a microscope instead of comparators which permits the operator to control the orientation of the platform assemblies. Recent developments indicate that optimum bonding pressure and temperature conditions permit strong bonds with short dwell times. Therefore, the second machine features only one bonding nest.

Both machines employ the thermocompression bonding principle, however, two methods of severing the gold wire after completing a bonding cycle are employed. The first machine employs tension, the second machine employs shearing.

ENGINEERING STATUS

Prove-in of the first Wire Bonding Machine is in progress. Mechanically and electrically the machine performs the specified functions. However, difficulties were met with the basic principle employed in gold wire handling.

Presently, the main prove-in objective is to execute complete bonding cycles continuously on successive platform assemblies. A complete bonding cycle in this instance involves bonding to an internal header lead and then to a gold plated platform not containing a wafer. Accuracy of bonding tip motions is good. Experimentally, individual bonds were made successfully between the internal header lead and the gold plated platform. In order to wire bond to wafer stripes with the machine; header lead location, wafer location with respect to the header leads, and stripe location on the wafer must be held to close tolerances. Special arrangements will be made to obtain the required wafer bonded assemblies; at the present time, bonding to platforms without wafers is acceptable.

Strong bonds were obtained with 12-1/2 grams bonding tip pressure. After applying the brake to the spool, the wire did not break adjacent to the bond as required. Therefore, the bonding pressure was increased to 15 grams. At this pressure, the wire consistently breaks as desired, at the bond.

Feeding of gold wire also presented a problem. This problem was reduced considerably after using headers with a 15 mil post height instead of a 35

mil post height.

Work is being continued on the problem of maintaining the wire at the bonding tip after rupturing by applying tension. New bonding tips were developed which improved conditions, however, the result was not satisfactory. Since the elasticity of the gold wire is involved in losing the wire tail at the bonding tip, a new braking device was installed to reduce the effective length of the gold wire exposed to tension. Here, again, the result was not satisfactory.

After accomplishing the main objective of maintaining continuity of the gold wire, problems associated with refinement of wire bonding will be more precisely defined. These associated problems include perfecting cam operations; braking of wire carrying spools; improving illumination of the optical system; and providing indicators which inform the operator whether or not wire feed is maintained.

Development and design of the second wire bonding machine were completed. This machine is now being built.

CONCLUSIONS

From mechanical and electrical point of view, prove-in of the first wire bonding machine is 90 per cent complete. A few refinements are possible and will be made. The main objective remaining is to achieve continuous bonding. This work is related to the basic Wire Bonding concept on which operation of the machine is based rather than to design of the machine. Work will continue to overcome this problem.

Construction of the second wire bonding machine was just started.

OBJECTIVES FOR THE NEXT QUARTER

1. Achieve continuous bonding operation on the first machine.

2. Complete construction of the second machine.

FINAL CLEANING - M. N. Reppert

GENERAL

In accordance with Contract Modification No. 19, Emitter Etching is now entitled Final Cleaning even though the machine was completed during the fifteenth quarter as the Emitter Etching Machine. Beginning with this report, the Emitter Etching Machine will be called the Final Cleaning Machine, since this title more accurately described the operation performed.

Final Cleaning is performed on wire bonded headers prior to encapsulation. Completed subassemblies are successively subjected to three timed operations as follows: hot hydrogen peroxide wash, deionized water rinse, acetone dip. The Final Cleaning Machine (Figure 4-6) consists of four stations: an aligning station which properly aligns headers wafer side down contained in a loaded magazine; two bubbler stations which contain 600 individual bubbling cups supplying cleaning agents to each header in a magazine; and a hooded acetone dip station.

Four tanks for preparing and supplying cleaning agents are installed behind the machine. The control panel is located immediately above the peroxide washing station on the right. It contains four cycle timers, two thermometers, two Solu Bridges for monitoring water purity, seven pushbuttons for pump and cycle controls, and three indicator lamps. These indicator lamps are automatically lit by microswitches which start a cleaning cycle as soon as a magazine is in position. Cycle timers turn the lamps "OFF" when cycles are completed.

The magazine output of the Wire Bonding Machine containing 600 wire bonded headers is the input to the Final Cleaning Machine. Prior to cleaning, header height is set at the aligning station. Loaded magazines with header

properly aligned are successively processed wafer side down through hot hydrogen peroxide washing, deionized water rinsing and acetone dipping. Output of the machine is presently limited by the rinsing period. By adding several rinsing stations, machine output can be multiplied.

ENGINEERING STATUS

Prove-in and shop trial were completed during the fifteenth quarter. The machine is now installed for pilot production in the manufacturing area. Several controlled evaluations of the completed machine were conducted. Favorable results were obtained after minor adjustments during prove-in.

Development and prove-in progressed steadily since the machine was mechanically simple; however, during prove-in it was necessary to rework the peroxide washing and the deionized water rinsing stations so the bubbling cups were properly centered under each header. Since reworking these stations and completely flushing the system after installation, the Final Cleaning Machine has operated satisfactorily.

Purity of hot deionized water was a prime concern during machine development, since a stainless steel storage tank was being considered. Before construction was begun, this problem was investigated. Results of the investigation indicated that water purity was reduced, but remained safely below the specified purity limit when using a stainless steel storage tank. Hence, a stainless steel storage tank was specified.

CONCLUSIONS

The Final Cleaning Machine is completed and is now available for pilot production. Limited comparison of mechanized and manual Final Cleaning indicate that an increased yield should be realized from mechanized Final Cleaning.

Since this machine was completed previously, this narrative is included for this report only to review machine status after extensive contract modification.

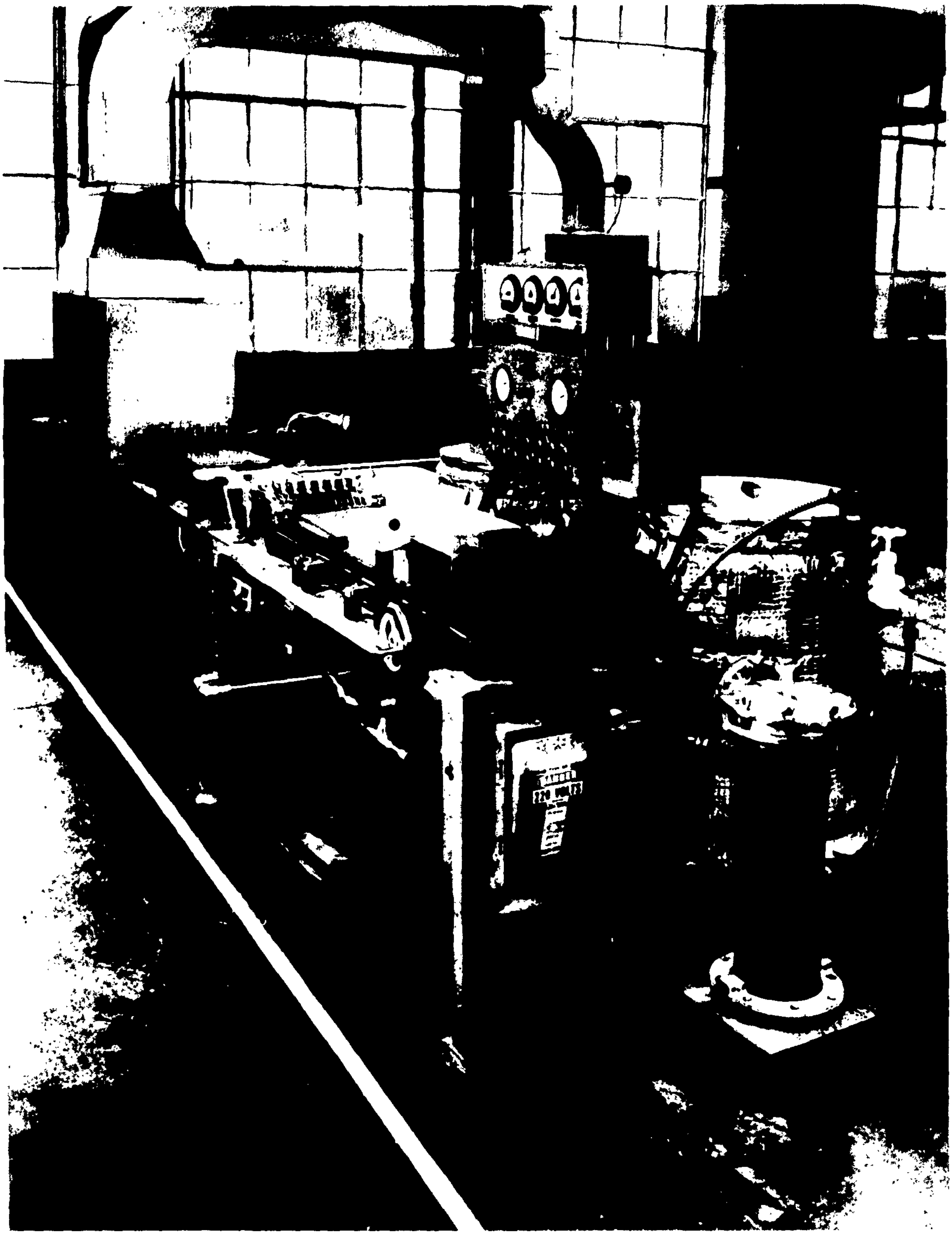

FIGURE 4-6 FINAL CLEANING MACHINE

CLOSURE WELDING - R. W. Ingham

GENERAL

In previous quarterly reports Closure Welding was entitled Bake-Out and Can-to-Header Welding. During the fifteenth quarter process development was finalized, and bake-out was eliminated from the process. Consequently, the title of the operation was changed on Contract Modification No. 19 to describe the operation actually mechanized.

The Closure Welding Machine will mechanize assembly, gas flushing, and resistance welding of 2N559 and 2N1094 transistor assemblies. This operation completes a series of assembly operations designed to produce high reliability transistors. The machine will serve two functions: first, establish the ambient in which the transistor will operate and, second, provide a hermetically sealed package which retains the desired ambient and isolates it from the environment in which the transistor will be forced to operate.

ENGINEERING STATUS

Decisions related to the choice of the major components have been resolved. Any changes to the decisions already made will be minor. The indexing mechanism for transporting the units from one station to another will have 16 stations and a cycle time of approximately 5 seconds per index. Provisions for supplying three different gases will be built into the machine. Loading will be done manually so as to eliminate the use of lubricants inside the dry-box and also to minimize time lost in bringing the dry-box ambient down to operating conditions after maintenance. The machine is intended to operate at a rate that will pace the operator, but suitable controls will be provided to vary the machine speed so that it can be made

compatible with the ability of the individual operator.

CONCLUSIONS

The proposed design will provide a method of closure and gas flushing that will be superior to the present manual methods. Previous investigations have indicated that control of the ambient will improve reliability and yield.

OBJECTIVES FOR THE NEXT QUARTER

1. Complete Formal Design.

COATING - G. L. Greenlief

GENERAL

The Coating Machine will mechanize loading, fungus coating, and unloading operations of completed 2N559 and 2N1094 transistors.

Work has not been resumed since holding construction after completing design. Its status will be determined after evaluating this operation on a similar machine now under construction.

ENGINEERING STATUS

The design, by a contractor, has been finished, but construction has been delayed pending determination of need for this machine. The 2N560-2N1051-2N1195 Painting and Coating Machine built under PEM Contract No. DA-36-039-SC-81294 may be able to perform the 2N559 and 2N1094 Coating operation.

Minor revisions are being made to the 2N560-2N1051-2N1195 Painting and Coating Machine, to accommodate the 2N559-2N1094 Coating operation. Upon construction of the Painting and Coating Machine during the next quarter, an evaluation will be made to establish whether the 2N560-2N1051-2N1195 Painting and Coating Machine can adequately perform 2N559-2N1094 Coating. Completion or deletion of the 2N559-2N1094 Coating Machine is pending on this evaluation.

CONCLUSIONS

Design of the 2N559-2N1094 Coating Machine has been completed. Construction or deletion of this Machine will be determined after evaluating the Coating operation on the 2N560-2N1051-2N1195 Painting and Coating Machine.

OBJECTIVES FOR THE NEXT QUARTER

1. Evaluate the 2N559-2N1094 Coating operation on the 2N560-2N1051-2N1195

Painting and Coating Machine.

2. Determine Coating Machine status.

3. Start construction or delete the machine.

CARD LOADING - C. R. Fegley

GENERAL

Narratives for this operation have been variously identified as Test Holder Loader, Holder Loading, and most recently as Holder Loader. The title has now been changed to conform with its contract designation.

The Card Loading Machine is designed to position and to attach 2N559 transistors to test holders. Output of the machine will be the input to Testing and Date Stamping Machines.

Prove-in efforts have not been resumed. However, a feasibility study was completed and design of a modified replacement was begun.

ENGINEERING STATUS

The Card Loading Machine was originally designed and built to attach a 2N559 transistor having 2 7/8 inch leads to a test holder. During prove-in, lead length of 2N559 transistors was changed from 2 7/8 inches to 1 1/2 inches. Beçause of this change, a major redesign of this machine was required.

Through a feasibility study, it was found that it was more economical to build a new Card Loading Machine than modify the existing machine. This new machine will use a new, more efficient method of attaching the transistor to its test holder and will feed the test holder with mounted transistor directly into the test set.

Cost of designing and constructing a new machine will be less than modifying the existing machine. Subsequently, savings will also be realized since material handling has been cut to a minimum; and the new machine, when combined with the feeding mechanism of a Testing and Date Stamping

Machine, will occupy approximately ten percent of the floor space required by the existing machine.

CONCLUSIONS

Feasibility studies on modifying the original machine have been completed. Design of a modified replacement has been started.

OBJECTIVES FOR NEXT QUARTER

1. Complete design.
2. Start construction.

TESTING AND DATE STAMPING - 2N559 - D. H. Lockart

GENERAL

As a result of Contract Modification No. 19 the title of this machine has been changed from Testing and Packaging-2N559 to Testing and Date Stamping-2N559. While the testing portion of the machine has not been changed in any way, the auxiliary operations performed by the machine have been altered.

Originally the machine was to perform a packaging operation by placing good product in ordered configuration into a packing container. During the eleventh quarter the requirements placed on the machine by the packing operation were drastically reduced. All that was required at that time was that good devices be placed, loosely packed, in a container holding five hundred (500) units. The transistors, however, would have still been mounted on the cards to which they were attached prior to testing. Since that time the requirements of the ultimate users of 2N559 transistors have solidified, and a Packaging Machine has been added to the contract by Modification No. 19. This machine will meet the requirements of providing oriented packaged devices.

During the twelfth quarter consideration was given to incorporating the Date Stamping operation into the Testing and Packaging Machine. Since during testing the transistor is held securely in position and is properly oriented for stamping, it was logical to add this operation to the machine. Equipment for stamping an acceptance date on the top of the transistor can was designed and built as a part of this machine. The Stamping Machine was then eliminated from the contract also as a result of Modification No. 19.

The Testing and Date Stamping Machine provides a means for performing six (6) D.C. tests and three (3) switching time tests on 2N559 transistors on

a go, no-go basis. Subsequent to testing, means are provided for stamping an acceptance date on top of the can of all acceptable transistors. Devices which fail any one test are rejected immediately; good transistors are carried to an unloading station where they are automatically placed in a container.

The machine receives completed 2N559 transistors attached to a vulcanized fibre belt on 1 1/8 inch centers by means of heat sealable tape. The belt is cut into 1 1/8 inch wide individual cards with the transistor centered on the card. The resultant cards are then fed into position in a test holder. These operations are performed automatically by the card cutoff and feed mechanism which is powered by its own AC motor but is controlled by the main machine operating cycle.

Test holders are mounted on the carriers of a Ferguson Trans-O-Motor index table. Test modules are mounted on top of the index table with direct connections to individual test heads. After a card-mounted transistor is indexed to a position directly below one of the test heads, it is raised by cam action into test position. In this position the three (3) transistor leads contact three (3) parallel leaf spring probes which are connected to one of the test modules. Following a continuity check, biases are automatically applied and remain on the device a specified length of time which, incidentally, can be varied to suit requirements. When the test is performed a comparison is made between the test result and a reference voltage. On the basis of the comparison a go signal either is or is not transmitted to the reject mechanism. Upon receipt of a go signal the reject mechanism is raised above the test holder during its subsequent index to the next test position. If the signal is not received the mechanism remains in

place and strips the card and its transistor from the test holder. The card then falls into the reject bin for the particular test performed.

The machine is presently capable of performing the following tests:

I_{CBO}	BV_{CEV}	t_s
I_{EBO}	$V_{BE(sat)}$	t_f
BV_{EBO}	$V_{CE(sat)}$	t_r

Space has been provided for additional modules should they be required in the future.

A device which meets all test requirements remains in position on the test holder. During subsequent indexes of the Trans-O-Motor table the device reaches the date stamping station. Here, while the device is held in position by suitable fingers, a three-digit acceptance date is stamped on the top of the can by means of raised, inked numbers.

Following stamping good devices are indexed to the unloading station where they are stripped from the test holder by fixed metal fingers. Each good device is counted just prior to unloading. Rejected devices are counted when a particular test is failed thus giving a quick check on yield on individual tests.

This machine is in production trial. All mechanisms have been proved-in and have been operated under production conditions for limited periods. During the next year various production runs will be made on the machine to further evaluate its operation and to determine maintenance requirements.

ENGINEERING STATUS

Prove-in details of the Testing and Date Stamping Machine were completed

during the sixteenth quarter. Since that time standard devices have been periodically run through the machine for the purpose of checking calibration and to make certain that all mechanisms remain in operating condition. Various technical problems arose during the development and prove-in of this machine. One very important problem was to find a way of mounting the transistor so that its leads would be properly contained during testing. The 2N559 transistor was being processed at that time with 2 7/8 inch leads which had to be kept straight and properly oriented. This problem was solved by attaching the transistor leads to a vulcanized fibre strip with heat sealable plastic tape. The leads are spread so that they are on 1/4 inch centers at the point of contact with the test probes. The test contacts were made 3/16 inch wide so that variation in lead location could be tolerated.

Another major problem was to find a fail-safe method of unloading reject devices following each test. The solution to the problem consisted of providing reject solenoids which are activated on signal from the test module comparators. These solenoids on receipt of an accept signal lift reject fingers out of the path of the card-mounted transistors during table index. If no signal is received, the solenoids are not activated, and the fingers are held in position by compression springs.

Selection of a method of performing the switching time tests also proved to be somewhat of a problem. It was necessary to evaluate available commerical direct-reading equipment in order to avoid the time and expense involved in development and design. After a preliminary selection was made, equipment was procured and evaluated. Excellent results were obtained during the evaluation, and the equipment was incorporated in the machine.

During prove-in difficulty was encountered with the index table control

circuitry. The main problem was in the emergency stop circuit which had to be completely redesigned and rebuilt. Another prove-in problem was in the feeding of the transistor carrying vulcanized fibre strip. Several modifications of the guides and ways were necessary to prevent binding and jamming. Guides for the individual cards during their transfer to the test holders were also modified to provide more positive feeding.

No major problems developed in the design and prove-in of the DC test modules. Effort during prove-in was concentrated mainly on improving stability in the power supplies and in obtaining repeatability of readings.

CONCLUSION

The Testing and Date Stamping Machine is capable of performing six (6) DC and three (3) switching time tests on a go, no-go basis accurately and reliably. It will operate at an output rate commensurate with the design limits of the mechanical drive provided.

This narrative has been included as review for this report only since the machine was previously completed.

TESTING AND DATE STAMPING (2N1094-2N1195) - K. C. Whitefield

GENERAL

Formerly, this narrative was entitled Testing and Packaging (2N1094-2N1195). In order to conform with Contract Modification No. 19, this title has been changed to Testing and Date Stamping (2N1094-2N1195). The revised title describes the operation planned for the machine while remodifying the contract.

In the meantime, operations proposed for the Testing and Date Stamping Machine (2N1094-2N1195) have been reconsidered. Under the revised concept Testing and Data Collection will be performed on the machine. Thus, Date Stamping has been eliminated.

ENGINEERING STATUS

A general outline of the revised machine has been agreed upon and development has begun. This outline provides for a universal test set which will provide tests for all parameters of either 2N1094 or 2N1195 transistors and collect the test data on a tape.

Automatic programming of devices in sequence through a series of tests will be provided. The handling system will include test racks which provide device contacts and transport, electrical test stations and an automatic indexing mechanism.

The universal test set provided for Data Handling System (2N559-2N1094) will be studied during development since a similar test set is being considered for this operation. These studies will aid in developing the new testing concepts. With development of this testing concept, procedures for Group B and Group C military specification testing can also be developed. Most

Group B and all Group C electrical tests can also be performed and recorded on this test set.

CONCLUSIONS

The 2N1094-2N1195 Testing and Date Stamping Machine concept has been revised. The latest concept developed, Testing and Data Collection, has the following advantages:

1. Data recording will take place automatically as tests are performed.
2. The universal D.C. and "h" parameter test set is not limited to 2N1094 and 2N1195 transistors.

OBJECTIVES FOR NEXT QUARTER

1. Complete evaluation of universal test set of the Data Handling System and select device standards.
2. Initiate development of test procedures for Group B and C Mil-Spec testing.
3. Initiate purchase order for data storage.
4. Initiate design and construction of test racks.
5. Initiate design of mechanical handling system required for automatic testing.

DATA HANDLING - D. H. Lockart

GENERAL

The Data Handling System consists of transistor handling and test equipment, analog to digital conversion equipment, data recording equipment and a computer. The system is being used to generate transistor test data, to process this data and to convert it into forms useful for engineering evaluation.

A Texas Instrument TACT (Transistor and Component Tester) forms the nucleus of the data generating portion of the system. A switching time test module of Western Electric design is being developed to add to this portion. Mechanical indexing equipment for handling transistors during testing is also being designed and built by Western Electric. Analog to digital conversion equipment is a part of TACT.

A Friden Flexowriter and an IBM 526 Summary Punch are used for data recording. A Monrobot Mark II desk size computer is used for data processing. Punched card and punched paper tape inputs to the computer are provided. Computer outputs used are punched paper tape and typewritten data.

ENGINEERING STATUS

The mechanical indexing equipment for handling transistors during test is in the construction phase, with completion delayed until early in the next quarter. The equipment will index a ten-unit socket strip past a single test station. All tests to be performed on a single transistor will be made in sequence while the unit is in the test position. Data from each test will be recorded immediately after the test is made.

The TACT has been received and is proved-in for DC operation using manual insertion of transistors into a single test socket. Commercial equipment pro-

vided in the 1 KC "h" parameter module has not functioned properly, so this module has been returned to the supplier for repair. It is anticipated that this module will be available for prove-in within a few weeks, at which time final prove-in of the TACT can be completed.

The computer, all recording equipment, and computer input and output devices have been proved-in. No problems were encountered during this prove-in other than normal service calls. Programs for the computer are being written and evaluated.

Preliminary work on using the system in its entirety has started. Samples of production codes of transistors have been evaluated on the TACT. Data resulting from this evaluation has been recorded on both tape and cards. This information has been fed into the computer which has produced distributions of values on individual parameters and yield data. The desired result of this effort is a method of using sample test data to control production with a minimum of manual effort and with rapid feedback of information.

CONCLUSIONS

Preliminary results indicate that a stable, versatile data handling system has been provided. All necessary equipment for evaluating various methods of controlling production through sample test data is now available and is operating.

OBJECTIVES FOR NEXT QUARTER

1. Complete construction of the transistor handling equipment.
2. Design the switching time test module and start construction of the module.
3. Complete prove-in of TACT.
4. Continue development of system operating procedures and analysis of production control methods.

CARD TRIMMING AND PACKAGING - C. R. Fegley

GENERAL

A separate Card Trimming and Packaging Operation has been added to the mechanization program by Contract Modification No. 19. Card Trimming and Packaging were previously designed to follow testing on a combined Testing and Packaging Machine.

The Card Trimming and Packaging Machine will automatically punch a mylar shipping belt, index the belt to a manual loading station and finally wind the belt on a shipping reel. Since 2N559 and 2N1094 transistors are now processed with 1 1/2 inch leads instead of 2 7/8 inch leads, the card and lead trimming portion of the machine will not be required. Thus, the Card Trimming and Packaging Machine is basically a packing machine since card trimming was deleted before construction began.

ENGINEERING STATUS

The design phase of the Card Trimming and Packaging Machine has been completed. All commercial components have been received. Assembly has begun.

CONCLUSIONS

A suitable machine design has been completed for handling a mylar belt while manually loading 2N559 or 2N1094 transistors.

OBJECTIVES FOR NEXT QUARTER

1. Complete construction.
2. Prove-in.

SECTION V

CONTRACT MODIFICATION - H. J. Huber

During the seventeenth quarter, PEM Contract No. DA-36-039-SC-72729 was modified. This contract modification resulted from the contract negotiations initiated by a change in the objective planning level for 2N559-2N1094 mechanization during the thirteenth quarter and expanded by a review of all contract work statements on the basis of machine utilization, economics and state of the art during subsequent quarters.

The contract modification basically affects the 2N559-2N1094 mechanization with a reduction in the total number of machines from thirty-eight (38) to thirty-seven (37) resulting from a deletion of seven (7) machines and an addition of six (6) machines. Summarizing this contract modification, the task includes the design, procurement and refinement of the indicated quantities of machines for each of the following operations:

Operation	Quantity
1. Cleaning Header Lead Wire	1
2. Piece Part Cleaning	1
3. Piece Part Gold Plating	1
4. Platform Lead Welding	3
5. Header Assembling	2
6. Header Glassing	1
7. Header Lead Trimming	1
8. Strip Perforating and Welding	2
9. Header Continuous Rack Plating	1
10. Can Punching and Coding*	1
11. Can Getter Assembling	1

Cleaning	Quantity
12. Slice Scribing	1
13. Wafer Breaking, Screening and Loading	2
14. Wafer Bonding	3
15. Wire Bonding	6
16. Final Cleaning	1
17. Closure Welding	2
18. Coating	1
19. Card Loading	1
20. Testing and Date Stamping - 2N559	1
21. Testing and Date Stamping - 2N1094-2N1194	1
22. Data Handling	1
23. Card Trimming and Packaging	2

* Tooling and Facilities only.

Delivery for these machines and for the associated final reports has been extended six (6) months. The machines are now scheduled for completion on or before December 31, 1962 and the final reports on or before March 31, 1963. In addition, this contract modification also extends the delivery of the Final Report and the Bill of Part and Materials for Devices 7 and 12 six months to March 31, 1962.

SECTION VI

IDENTIFICATION OF PERSONNEL

1. PERSONNEL CHANGES

The following personnel changes were effected this quarter:

Added to the contract were:

G. L. Greenlief - W.E.

R. C. Hermann - W.E.

M. N. Reppert - W.E.

L. R. Sell - W.E.

Deleted from the contract:

H. L. Kegerise - W.E.

R. F. Lipscomb - W.E.

B. W. Shugars - W.E.

2. ENGINEERING TIME

Western Electric personnel spent approximately 2,730 engineering hours between September 10, 1961 and December 10, 1961 that were directed toward completing the contract.

3. PERSONNEL BIOGRAPHIES

G. L. GREENLIEF

G. L. Greenlief, a native of Frankfort, Kentucky, graduated from the University of Kentucky, in 1960, with a B.S. degree in Industrial Administration. While matriculating at college he was employed by the Schenley Distilling Co., Inc., Frankfort, Kentucky, as an assistant engineer in the production and maintenance engineering department. In 1960 he joined the engineering staff of the Western Electric Company

at Laureldale where he is presently engaged in the development of mechanized equipment for the manufacture of semiconductor devices.

R. C. HERMANN

R. C. Hermann, a native of Belleville, New Jersey, attended Newark College of Engineering, graduating in 1951 with a B.S. degree in Mechanical Engineering and receiving an M.S. in Engineering in 1954. In 1956 he was licensed by the state of New Jersey as a registered professional engineer. He joined the Western Electric Company in 1951 at the Kearny Works and was associated there with various Factory, Product and Development Engineering assignments. In December 1959 he was transferred to Laureldale and was assigned to be in charge of the group responsible for the engineering under PEM Contract DA-36-039-SC-81294. Recently, he assumed responsibilities for engineering under this Contract.

M. N. REPPERT

M. N. Reppert, a native of Shoemakersville, Pennsylvania, graduated from Temple University in 1951 with a B.S. degree in Secondary Education, majoring in General Science. Before matriculating at Temple University, he served in the U. S. Air Force as a Radio Operator-Gunner and as a Gunnery Instructor. Since joining Western Electric in 1955, he has been assigned as a technical assistant to various transistor and diode production operations. He was also assigned to the Laureldale Branch of Bell Telephone Laboratories for over a year, where he assisted in various diode developments.

L. R. SELL

L. R. Sell, a native of Reading, Pennsylvania, graduated from high school in 1950. He entered Pennsylvania State University and in 1956 received a

B.S. degree in Mechanical Engineering. Following graduation he worked for the Martin Aircraft Company in the propulsion department of the Experimental Aero Section. In 1957 he joined the Western Electric Company at Laureldale and was immediately loaned to Bell Telephone Laboratories Allentown for one year and then to the Bell Telephone Laboratories in Laureldale for two years. During this time he worked in encapsulation developments such as glass and ceramic-to-metal seals, cold welding, brazing, etc. In December of 1960 he returned to Western Electric Company and has been engaged in the development of new oxidizing and glassing operations on piece part subassembly manufacturing.